

Grazing Incidence X-ray Diffraction Studies for an Effect of Al Substrate-Induced Polyurethane Crystallization on Bond Strength

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Beamline(s): X14A, X18A

Grazing incidence X-ray diffraction was carried out to analyze the variation of crystallinity along polyurethane film depth by controlling incident angle. Crystallinity, coherence length, interplanar spacing, integrated intensity of intense polyurethane peaks, and ratio of integrated intensities were obtained in non-aged and aged PU-120, PU-375, PU-600 films bonded to aluminum substrate. Aging led to the improvement of bulk crystallinity in all the samples, and its effect on adhesion was significant in the PU-375 film, resulting in the dramatic increase of bond strength. The invariance of coherence length from air facing polymer surface down to polymer/Al interface was seen in PU-120 and PU-375 samples, implying that the substrate-induced ordering is less effective on the average crystallite size. However, the variation of interplanar spacing, approaching the value for a polyurethane bulk, indicates that better order is found near interface. The substrate-induced ordering was seen in the profile of integrated intensity increasing linearly from polymer surface down to interface (see Figure 1). It was also found that the extent of strain, expressed as $\Delta d_{(021)}$, is another contributor to determine adhesion strength.

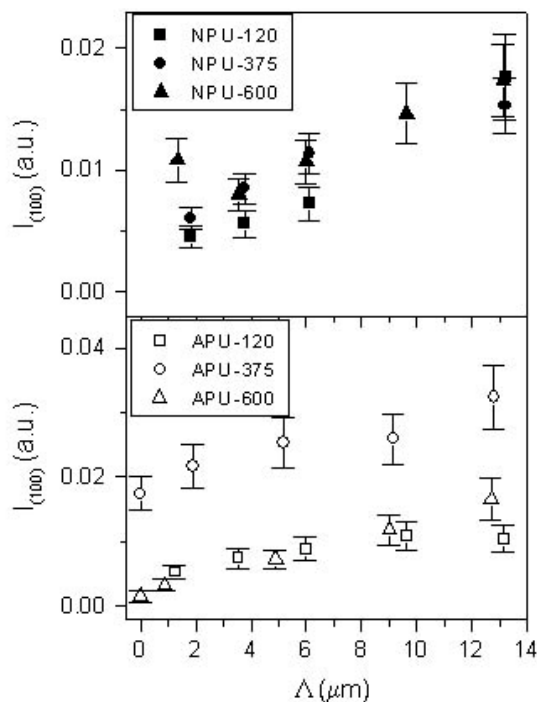


Figure 1. Variation in integrated intensity for the (100) reflection as a function of penetration depth. The integrated intensity increases down to the interface along film depth, implying that substrate-induced ordering takes place significantly near the interface.